Idaho State Department of Agriculture
Division of Agricultural Resources

Ground Water Quality of Northern Owyhee County Aquifers

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Introduction

The Idaho State Department of Agriculture (ISDA) developed the Regional Agricultural Ground Water Quality Monitoring Program to characterize degradation of ground water quality by contaminants leaching from agricultural sources. ISDA currently is conducting monitoring at 12 regions in Idaho, including a project in Owyhee County (Figure 1). The objectives of the program are to: (1) characterize ground water quality, primarily related to nitrate-nitrogen (NO_3-N) and pesticides, (2) determine if legal pesticide use contributes to aquifer degradation, (3) relate data to agricultural land use practices, and (4) provide data to support Best Management Practices (BMP) and/or regulatory decision making and evaluation processes.

The ISDA Owyhee County regional monitoring project began in 1999 as a result of previous monitoring by the Idaho Department of Water Resources (IDWR). Four water wells in the area, tested during the first round of IDWR's Statewide Ambient Ground Water Quality Monitoring Program, exceeded the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/L) for NO_3-N (Neely and Crockett, 1999). To establish this regional monitoring project, ISDA randomly selected domestic wells in the area and coordinated with homeowners to conduct ground water sampling.

Nutrients, pesticides, and common ions were evaluated during the four years (1999 through 2002) of ISDA's sampling efforts. Laboratory results have indicated that numerous domestic wells located southwest of Homedale and Marsing, and west of Grand View have NO_3-N levels that suggest some type of land use influences on the ground water. Low level concentrations of various pesticides were detected in numerous wells.

ISDA is currently working to advise residents and officials of the area to minimize further ground water contamination and possible health risks. Ground water monitoring will continue at least through the year 2003 to assist with these efforts.

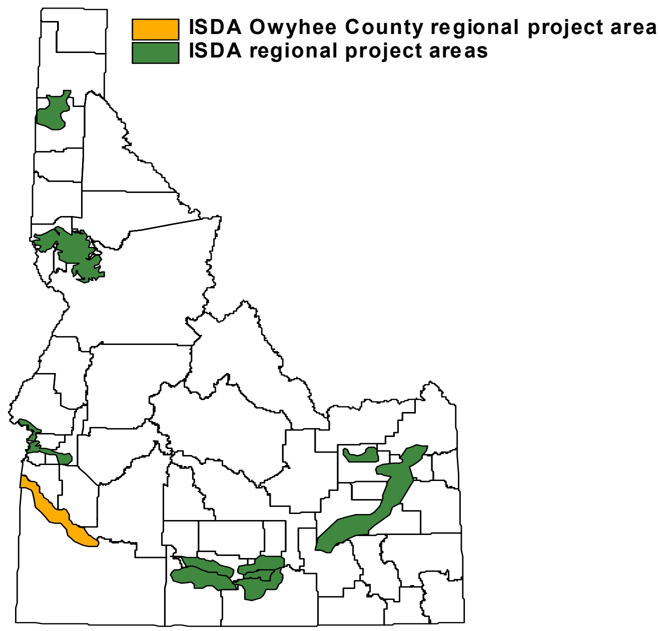

Figure 1. Location of Owyhee County regional project and other ISDA regional project areas.

Methods

To establish this project, ISDA statistically assessed IDWR Statewide Program nitrate, chloride, and atrazine monitoring data. ISDA statistically determined that sampling 37 randomly selected domestic wells would provide adequate data to evaluate overall ground water quality underlying the area. All sampling was conducted after a quality assurance project plan (QAPP) was established. Permission was gained from the land owners prior to sampling.

Nutrients and other common ions were evaluated every year since 1999. All sample collections followed established ISDA protocols (on file at ISDA main office) for handling, storage, and shipping. Samples were sent to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho. UIASL conducted tests for nitrate, nitrite, ammonia, orthophosphorous, chloride, sulfate, bromide, and fluoride using EPA Methods 300.0 and 350.1. Duplicates, splits, and matrix spikes/matrix spike duplicates were collected and submitted as a part of the QAPP.

In 2000 and 2001, samples were collected from selected wells following ISDA protocols for nitrogen isotope analysis. Samples were frozen and shipped via Federal Express one-day service to the ^{15}N Analysis Service, Department of Natural Resources and Earth Sciences, University of Illinois Champaign-Urbana. In 2002 samples were collected from selected wells for nitrogen and oxygen isotope analysis, following ISDA protocols. The samples were frozen and shipped via Federal Express one-day service to North Carolina State University laboratory.

In 1999 through 2001, samples were sent to UIASL for pesticide analysis. UIASL used gas chromatography scans for pesticides utilizing EPA Methods 507, 508, 515.1, and 531.1. In 2002, samples were sent to UIASL for EPA Method 515.1 pesticide analysis. Duplicates, splits, and matrix spikes/matrix spike duplicates were collected and submitted as a part of the QAPP. Additional wells were tested in 2001 through an EPA grant to evaluate an area near Homedale where the pesticide dacthal (DCPA) was detected from prior testing.

Description of Project Area

The Owyhee County regional monitoring project encompasses an approximately eight mile wide and 75 mile long area of irrigated agricultural land adjacent to the Snake River (Figures 1 and 2). The main source of irrigation is provided by diversions from the Snake River (Priest et al., 1972). However, ground water also is used in the area for production agriculture. Local irrigation systems vary from the typical and historic practice of flood and furrow irrigation to more modern techniques of sprinkler irrigation. IDWR land use maps indicate that approximately 50% of the project area is furrow irrigated and 13% is sprinkler irrigated. Major crops in the area include onions, alfalfa, sugar beets, potatoes, corn, wheat, barley, beans, and mint (Parliman, 1983). In addition, there are livestock operations that range in size from a few individual animals to several thousand head dairy farms (Carlson et al., 2001).

The major soil associations in the northwest section of the project area (Homedale and Marsing area) are Furbyfill-Cencove-Feltham and Greenleaf-Nyssaton-Garbertt associations (Priest et al., 1972). These soils are well drained to somewhat excessively drained sandy to silty loams. The soil types in the southeast section of the project area (Melba to Grand View) are the Typic Torriorthents-Mazuma-Vanderhoff series (US Department of Agriculture, 1991). These soils vary from very fine sandy loam to loamy coarse sand and are well drained to excessively drained. Well drained sandy soils generally increase the vulnerability of aquifer contamination from nutrients leaching into the ground water.

The sediments in the project area are classified as the Idaho Group geologic formation (U.S. Geological Society, 2000). The sediments are believed to be deposited by prehistoric Lake Idaho and recent deposition from the Snake River. A “blue clay” layer is found on well drillers’ reports on file at IDWR for many of project wells. The blue clay layer is part of the Glenns Ferry Formation and the low permeability of the clay produces a confined aquifer under the layer (Othberg, 1994).

Ground water used for domestic purposes in the project area appears to come from two sources: (1) a shallow

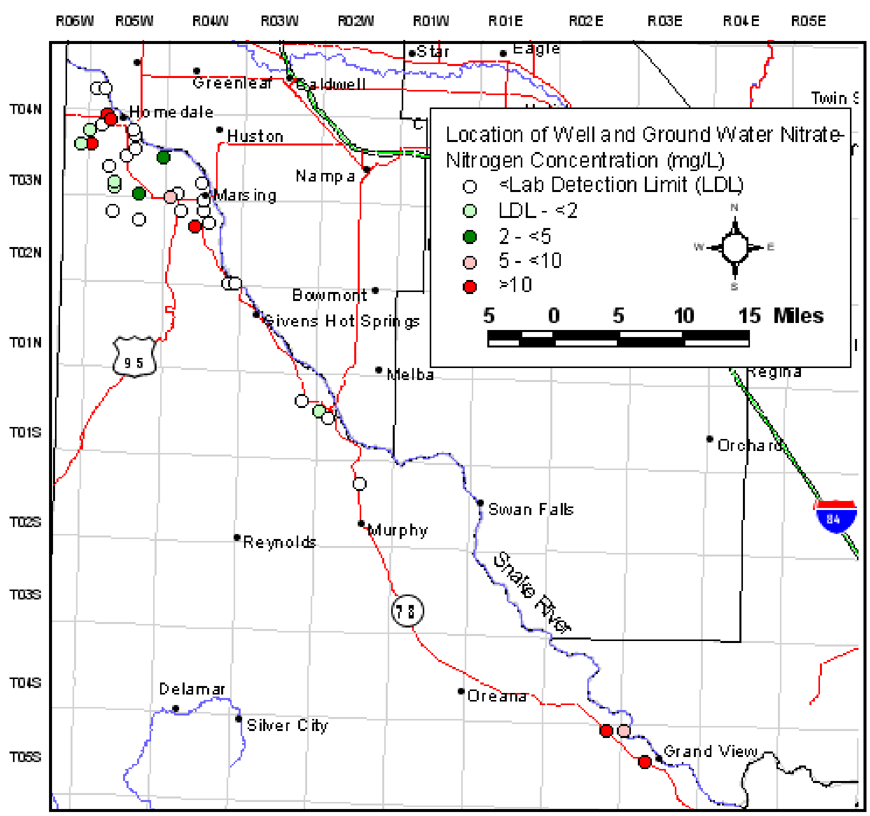

Figure 2. Locations of wells sampled by ISDA in Owyhee County, 2002. Colors represent nitrate-nitrogen concentration range measured in ground water from each well.

system of coarse grained sands and gravels, and (2) a deeper confined system of black sand under the blue clay layer (Carlson et al., 2001). Well drillers' reports indicate the shallow aquifer to be approximately 50 feet below the ground surface and the deeper aquifer to be located at varying depths, generally less than 300 feet. Based on well driller's reports from domestic wells, typical depth to ground water is less than 40 feet. The shallow aquifer is composed of alluvial deposits, mainly sand and gravel, with a few thin interbedded clay layers. The shallow subsurface alluvial deposits are conducive to leaching of contaminants. Potential sources for nitrate leaching to the ground water in the area include applied nitrogen-based fertilizers, septic systems, cattle manure, legume crops, and wastewater lagoons. Potential sources of recharge to this shallow system are applied irrigation waters, canal leakage, and precipitation. The general ground water movement appears to be toward the Snake River, which is an area of probable ground water discharge (Carlson et al., 2001).

Results

Sampling results of the first four years indicate NO_3-N and pesticide impacts have occurred to the aquifer. Results are summarized and presented in the following sections.

Nitrate

Thirty-six wells were sampled in 2002 for NO_3-N (Figure 2). Nitrate-nitrogen concentrations are most elevated in the areas southwest of Homedale and Marsing, and west of Grand View (Figure 2). The number of detections over 10 mg/L is of concern because of potential health risks.

Table 1 presents statistics for 32 wells that have been sampled consistently for four years (1999 to 2002). Approximately 37 wells have been sampled each year; however, only the 32 wells that have been consistently sampled every year are used for the statistical analysis in Table 1.

Results of ground water sampling in the project area indicate increases in the mean NO_3-N concentration from 1999 to 2001, then a decrease in 2002 to the lowest mean NO_3-N concentration for all four monitoring years (Table 1). The maximum concentration during 2002 was 22 mg/L. Five wells, or 16%, had NO_3-N concentrations over the MCL health standard of 10 mg/L, which has been consistent for all four sampling years. The median NO_3-N concentration was less than the laboratory detection limit (0.033 mg/L), which has also been consistent for all four sampling years (Table 1).

Table 1. Nitrate-nitrogen results for Owyhee County regional project, 1999-2002.[1]

Concentration Range (mg/L)	1999 32 Wells	2000 32 Wells	2001 32 Wells	2002 32 Wells
<LDL[2] (0.033)	20 (63%)	17 (53%)	18 (56%)	20 (63%)
LDL to <2.0	4 (12%)	7 (22%)	5 (16%)	3 (9%)
2.0 to <5.0	2 (6%)	2 (6%)	3 (9%)	2 (6%)
5.0 to <10.0	1 (3%)	1 (3%)	1 (3%)	2 (6%)
>10.0	5 (16%)	5 (16%)	5 (16%)	5 (16%)
Mean Value	2.9 mg/L	3.2 mg/L	4.5 mg/L	2.7 mg/L
Median Value	<LDL	<LDL	<LDL	<LDL
Maximum Value	21 mg/L	26 mg/L	47 mg/L	22 mg/L

[1]Table 1 statistics are for the same 32 wells sampled each year. ISDA sampled more than 32 wells per sampling year, however, only wells that were consistently sampled were used for the statistics.

Ammonia

Ammonia (NH_4) is a naturally occurring compound within the environment. Elevated concentrations of ammonia within the ground water are not common because ammonia is normally recycled by natural processes within the environment. However, human activities described for NO_3-N sources (e.g., fertilizer, manure) also can contribute to the presence of ammonia in the environment. The North Owyhee regional monitoring project is the only ISDA project in which ammonia concentrations are elevated (Table 2). Elevated concentrations of ammonia in the ground water are thought to occur in areas where there is not enough oxygen in the ground water to convert the ammonia to nitrate.

Table 2. Ammonia results for Owyhee County regional project, 1999-2002.[1]

Concentration Range (mg/L)	1999 32 Wells	2000 32 Wells	2001 32 Wells	2002 32 Wells
<LDL[2] (0.1)	7 (22%)	6 (19%)	3 (9.5%)	7 (22%)
LDL to <2.0	8 (25%)	9 (28%)	12 (37.5%)	9 (28%)
2.0 to <5.0	3 (9.5%)	4 (12.5%)	4 (12.5%)	5 (16%)
5.0 to <10.0	11 (34%)	11 (34%)	8 (25%)	11 (34%)
>10.0	3 (9.5%)	2 (6.5%)	5 (15.5%)	0
Mean Value	4.2 mg/L	4 mg/L	4.4 mg/L	3.4 mg/L
Median Value	2.7 mg/L	2.6 mg/L	2.6 mg/L	1.9 mg/L
Maximum Value	11 mg/L	12 mg/L	12 mg/L	9.8 mg/L

[1]Table 2 statistics are for the same 32 wells sampled each year. ISDA sampled more than 32 wells per sampling year, however, only wells that were consistently sampled were used for the statistics.
[2]LDL - Laboratory Detection Limit, which is 0.1 mg/L.

Table 2 presents statistics for 32 wells that have been sampled consistently for four years (1999 to 2002). Approximately 37 wells have been sampled each year; however, only the

Table 3. Pesticide results for Owyhee County regional project, 1999.*

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
2,4-Dichlorobenzoic acid	1	0.11	0.11	0.10 (RfD)[1]
3,5-Dichlorobenzoic acid	1	0.11	0.11	0.10 (RfD)[1]
Atrazine	3	0.05 - 0.37	0.24	3 (MCL)[2]
Dacthal (DCPA)	9	0.09 - 65	14	100 (RfD)[1]
Simazine	1	0.04	0.04	4 (MCL)[2]

*Note: 37 wells were tested for pesticides in 1999
[1]RfD - EPA reference doses for 10 kg child
[2]MCL - EPA maximum contaminate level

Table 4. Pesticide results for Owyhee County regional project, 2000.*

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Dacthal (DCPA)	2	47 - 48	47.5	100 (RfD)[1]

*Note: 2 wells were tested for pesticides in 1999
[1]RfD - EPA reference dose for 10 kg child

Table 5. Pesticide results for Owyhee County regional project, 2001.*

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Atrazine	4	0.03 - 0.08	0.06	3 (MCL)[1]
Dacthal (DCPA)	19	0.08 - 67	10.2	100 (RfD)[2]
Desethyl Atrazine	5	0.03 - 0.16	0.07	35 (RfD)[2]

*Note: 42 wells were tested for pesticides in 2001, including 5 new wells sampled from an EPA grant
[1]MCL - EPA maximum contaminate level
[2]RfD - EPA reference dose for 10 kg child

32 wells that have been consistently sampled every year are used for the statistical analysis in Table 2. Results of ground water sampling in the project area indicates that the mean value of ammonia has fluctuated between 3.4 mg/L to 4.4 mg/L. In 2002, no wells had an ammonia concentration over 10 mg/L. Although there is no MCL for ammonia, it is generally thought that concentrations below 10 mg/L do not pose a health threat to humans. From 1999 to 2002 the percentage of wells that had ammonia concentrations over 10 mg/L ranged between 0% to 16% (Table 2).

Pesticides

Ground water samples were collected each year for pesticide analysis. Samples were sent to the UIASL for analysis. Samples were tested for various pesticides utilizing EPA Methods 507, 508, 515.1, and 531.1.

Thirty-seven wells were sampled for pesticides in 1999. Analysis of samples detected the presence of dacthal (DCPA), atrazine, 2,4-dichlorobenzoic acid, 3,5-dichlorobenzoic acid, and simazine in order of most to least frequently detected (Table 3). All compounds detected had concentrations less than EPA health standards except 2,4-dichlorobenzoic acid and 3,5-dichlorobenzoic acid. Both compounds were detected at concentrations of 0.11 micrograms per liter (µg/L). These levels exceeded the health standard based on the EPA reference dose for a 10 kilogram (kg) child of 0.10 µg/L (Table 3). These compounds were not detected in subsequent sampling in 2000 through 2002. Both 2,4-dichlorobenzoic acid and 3,5-dichlorobenzoic acid are not common compounds used in pesticides. The source of these two compounds in the ground water is unclear.

Two wells were sampled for pesticides in 2000 (Table 4). The wells were chosen for pesticide analysis because each had dacthal (DCPA) concentrations over 20% of the EPA MCL during the 1999 sampling. Dacthal (DCPA) was the only pesticide positively detected in the two wells (Table 4). The concentrations of dacthal (DCPA) detected in the two wells were 47 µg/L and 48 µg/L, at about 50% of the reference dose of 100 µg/L set by the EPA.

In 2001, 42 wells were tested for pesticides, including five new wells added to the project through additional grant money provided by EPA. The pesticides positively detected were dacthal (DCPA), desethyl atrazine, and atrazine in order of most to least frequently detected (Table 5). All pesticides detected had concentrations less than health standards set by the EPA, however one well was over 50% of the health standard for dacthal (DCPA). The total number of pesticide detections in 2001 was 28,

Table 6. Pesticide results for Owyhee County regional project, 2002.*

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Health Standard (µg/L)
Dacthal (DCPA)	9	1.6 - 26	9.9	100 (RfD)[1]

*Note: 9 wells were tested for pesticides in 2002
[1]RfD - EPA reference dose for 10 kg child

Table 7. 2000 through 2002 $\delta^{15}N$ results for selected wells.

Well ID	2000 Data			2001 Data			2002 Data			
	NO_3 (mg/L)	NH_4 (mg/L)	$\delta^{15}N$ Values ($^0/_{00}$)	NO_3 (mg/L)	NH_4 (mg/L)	$\delta^{15}N$ Values ($^0/_{00}$)	NO_3 (mg/L)	NH_4 (mg/L)	$\delta^{15}N$ Values ($^0/_{00}$)	O-18 Values ($^0/_{00}$)
8600101	26	ND[1]	9.74	47	ND[1]	9.85	22	ND	5.559	1.077
8600901	ND[1]	6.3	9.17	ND[1]	7.6	5.31	ND[1]	5.8	8.042	NT[2]
8601101	16	ND[1]	8.73	12	0.26	2.85	11	ND[1]	8.6	0.733
8601401	15	0.62	9.68	26	ND[1]	5.13	12	ND[1]	7.544	0.280
8602001	3.8	0.48	12.38	4.3	1	3.66	5.1	0.44	16.454	1.469
8602301	0.49	12	7.41	3.9	8.1	10.77	2.1	5.4	16.84	3.400
8602401	ND[1]	7	5.09	ND[1]	7.9	2.81	ND[1]	6.1	3.405	NT[2]
8602501	ND[1]	6.4	7.12	ND[1]	5.2	NT[2]	ND[1]	4.2	3.417	NT[2]
8602801	17	ND[1]	7.21	13	0.16	0.34	12	ND[1]	5.727	0.659
8602901	ND[1]	8.8	7.15	ND[1]	11	5.34	ND[1]	9.5	4.701	NT[2]
8603301	13	8.4	20.69	25	10	3.55	12	8.3	8.611	0.025
8603401	6.2	ND[1]	8.39	6.4	ND[1]	11.16	6	ND[1]	13.663	1.448

[1]ND - Laboratory non detect
[2]NT - Not tested

which was an increase from the 15 positive detections in 1999.

Nine wells were sampled for pesticides in 2002. The wells were chosen for pesticide analysis because each had dacthal (DCPA) concentrations over 20% of the EPA MCL during the 2001 sampling. Dacthal (DCPA) was the only pesticide positively detected in the nine wells (Table 6). The concentrations of dacthal (DCPA) detected in the nine wells ranged from 1.6 µg/L to 26 µg/L. The concentrations detected in 2002 were less than concentrations detected in 2001 suggesting a decreasing trend of dacthal (DCPA) concentration. All detections in 2002 were below the health standard for dacthal (DCPA) of 100 µg/L set by the EPA.

Nitrogen and Oxygen Isotopes

Overview

The ratio of the common nitrogen isotope ^{14}N to its less abundant counterpart ^{15}N relative to a known standard (denoted $\delta^{15}N$) can be useful in determining sources of NO_3-N. Common sources of NO_3-N in ground water are applied commercial fertilizers, animal or human waste, precipitation, and organic nitrogen within the soil. Each of these NO_3-N source categories has a potentially distinguishable nitrogen isotopic signature. Typical $\delta^{15}N$ ranges for fertilizer is –5 per mil ($^0/_{00}$) to +5 per mil ($^0/_{00}$), while typical waste sources have ranges greater than $10^0/_{00}$ (Kendall and McDonnell, 1998). Nitrogen isotope values between $5^0/_{00}$ and $10^0/_{00}$ are generally believed to indicate an organic or mixed source (Kendall and McDonnell, 1998).

Use of nitrogen isotopes as the sole means to determine NO_3-N sources should be done with great care. Nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake, etc.) that can modify the $\delta^{15}N$ values (Kendall and McDonnell, 1998). Furthermore, mixing of sources along shallow flowpaths makes determination of sources and extent of denitrification very difficult (Kendall and McDonnell, 1998).

Oxygen isotopes (denoted $\delta^{18}O$) can be used to trace the effects of denitrification (Clark and Fritz, 1997). Denitrification results in enrichment of both $\delta^{15}N$ and $\delta^{18}O$. By analyzing both $\delta^{15}N$ and $\delta^{18}O$, denitrification effects can be distinguished from mixing sources because the ratio of enrichment in $\delta^{15}N$ to $\delta^{18}O$ is about 2:1 (Kendall et. al, 1995).

Findings

In 2000 through 2002, ISDA conducted $\delta^{15}N$ testing as a possible indicator of source(s) of NO_3-N in the ground water. Twelve wells were tested in 2000 and 2002, and 11 wells were tested in 2001 (Table 7). Wells chosen for $\delta^{15}N$ testing had either elevated NO_3-N or ammonia (NH_4) concentrations in previous monitoring rounds. Table 7 shows the $\delta^{15}N$ results along with NO_3-N and NH_4 concentrations.

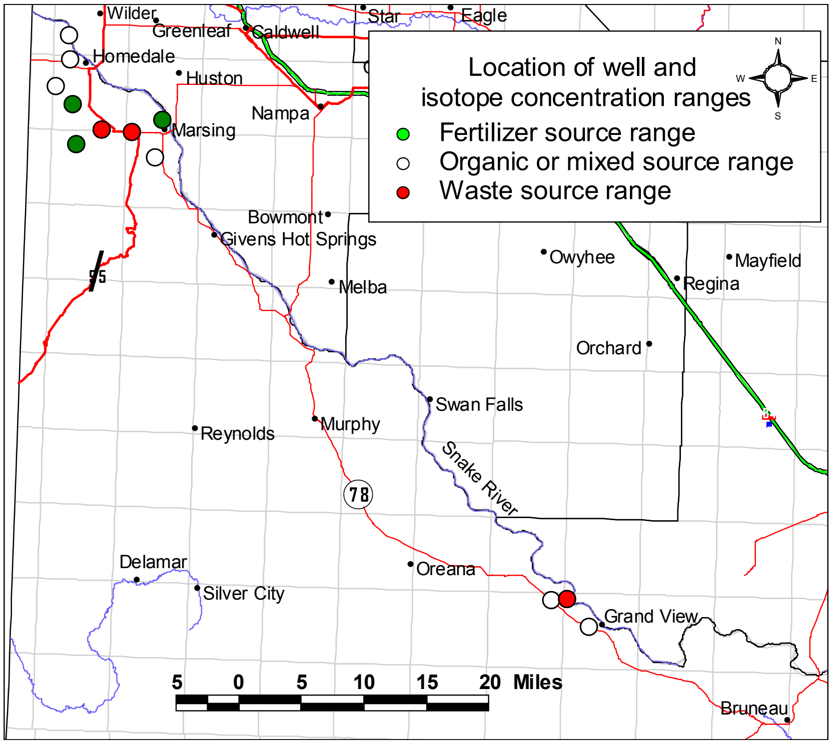

Figure 3. Locations of wells sampled by ISDA in Owyhee County, 2002. Colors represent possible sources of nitrate-nitrogen in ground water from each well based on $\delta^{15}N$ testing.

The 12 water samples collected in 2000 were sent to the University of Illinois Laboratory for $\delta^{15}N$ analysis. Results of $\delta^{15}N$ testing returned values that ranged from $5.09^{0}/_{00}$ to $20.69^{0}/_{00}$ (Table 7). Two wells had values that suggested an animal or human waste source; one was located west of Marsing, the other was located west of Grand View. The remaining ten wells tested had $\delta^{15}N$ values that indicated an organic or mixed source of nitrates.

The 11 water samples collected in 2001 were sent to the University of Illinois Laboratory for $\delta^{15}N$ analysis. Results of the $\delta^{15}N$ testing returned values that ranged from $0.84^{0}/_{00}$ to $11.16^{0}/_{00}$ (Table 7). Five wells had values that were within the fertilizer range for $\delta^{15}N$, four of these wells were located south of Homedale and west of Marsing, one was located west of Grand View. Two wells had values that suggested an animal or human waste source; one was located south of Homedale, and the other was located west of Grand View. The remaining four wells had $\delta^{15}N$ values that indicated an organic or mixed source of NO_3-N.

The 12 water samples collected in 2002 were sent to the University of North Carolina State Laboratory for $\delta^{15}N$ analysis. Results of the $\delta^{15}N$ testing returned values that ranged from $3.405^{0}/_{00}$ to $16.840^{0}/_{00}$ (Table 7). The isotope results suggest impacts from both fertilizers and waste. Three wells located west of Marsing had $\delta^{15}N$ values that suggested a fertilizer source of NO_3-N (Figure 3). Three wells had $\delta^{15}N$ values that suggested an animal or human waste source of NO_3-N, two were located west of Marsing and one located northwest of Grand View. The remaining six wells had $\delta^{15}N$ values that indicated an organic or mixed source of NO_3-N. The testing results indicate influences from both waste and fertilizer sources west of Marsing. This area has numerous dairies as well as agricultural fields, which could be a contributor to the elevated NO_3-N concentrations in the project area.

Eight water samples were collected in 2002 and sent to the University of North Carolina State Laboratory for $\delta^{18}O$ analysis. Results of the $\delta^{18}O$ returned values that ranged from $0.025^{0}/_{00}$ to $3.400^{0}/_{00}$ (Table 7). Nitrogen and oxygen isotope data were used to complete a linear regression analysis. Prior to the analysis, a significance level of 0.05 was selected for a statistical F test. The data passed a significance level of 0.02, and had a coefficient of determination (R^2) of 0.5552. The ratio of enrichment of $\delta^{15}N$ to $\delta^{18}O$ is approximately 6:1 within the wells sampled (Figure 4). The process of denitrification is thought to enrich $\delta^{15}N$ and $\delta^{18}O$ by 2:1 (Kendall et. al, 1995). The $\delta^{15}N$ and $\delta^{18}O$ data do not indicate isotope enrichment due to the denitrification process. Waste from animal operations and septic tanks in the project area could be a source of $\delta^{15}N$ values greater than $10^{0}/_{00}$ detected within the wells.

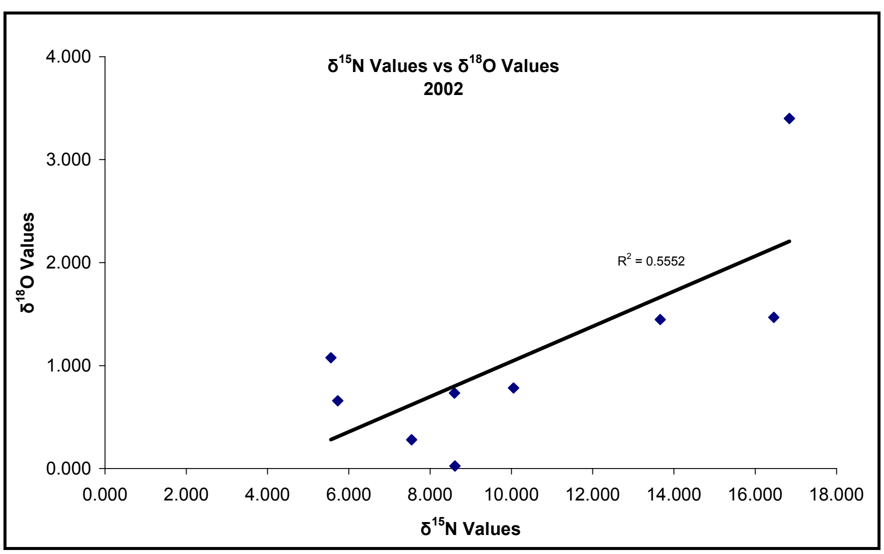

Figure 4. 2002 $\delta^{15}N$ versus $\delta^{18}O$ plot of selected wells. Axis values are in $^{0}/_{00}$.

Conclusions

Ground water within the shallow alluvial aquifer of the project area is being impacted from NO_3-N and pesticides. The number of wells with NO_3-N concentrations over the EPA MCL of 10 mg/L is of concern. Pesticide detections were generally low in concentration; however, there is concern about multiple pesticide detections per well and potentially detrimental health effects.

Mean ground water NO_3-N concentrations decreased in 2002, after two previous years of increasing. For each sampling year, 16% of the 32 wells sampled had NO_3-N concentrations exceeding the EPA MCL of 10 mg/L. The areas that had the highest NO_3-N concentrations were southwest of Homedale and Marsing, and west of Grand View. The majority of wells sampled were less than 250 feet deep.

The number of dacthal (DCPA) detections increased from 1999 to 2001. The compounds 2,4-dichlorobenzoic acid and 3.5-dichlorobenzoic acid both exceeded the EPA reference dose for a 10 kg child by 0.01 µg/L in 1999. However, these compounds were not detected in subsequent sampling. The source of these two compounds in the ground water could possibly be pesticide use, however the compounds are not commonly used for agricultural purposes.

Agricultural practices likely contribute to the NO_3-N and pesticide detections in the ground water of this project area. Animal wastes from dairies and feedlots are also a potential contributor of NO_3-N to the ground water. Testing results indicate NO_3-N and pesticide impacts to the shallow ground water of the project area are widespread. This is common in sparsely populated agricultural areas that have high agrichemical input and mostly furrow irrigation overlying a shallow alluvial aquifer. IDWR land use maps indicate that approximately 50% of the project area is furrow irrigated. Leaching of applied commercial fertilizers is probably a major cause of NO_3-N entering the ground water. Well drained sandy soils that are common in the project area increase the vulnerability of the aquifer to contamination from nutrients leaching into the ground water. Oxygen isotope analysis suggested a process other than denitrification for NO_3-N enrichment of $\delta^{15}N$ values. Nitrogen isotope testing suggested fertilizer and waste sources of NO_3-N within wells west of Marsing and Grandview.

Recommendations

To determine if current farming practices are contributing to ground water degradation and to locate other potential contaminant sources, the ISDA recommends continued monitoring in the project area.

Testing should include, but not be limited to:

- Continued ground water monitoring for nutrients, common ions, and pesticides.
- Continued nitrogen isotope testing to determine possible nitrate sources and relative ages of ground water.
- Continued oxygen isotope testing to determine effects of denitrification.
- Soil sampling and soil pore water sampling.

The ISDA further recommends that measures to reduce nitrate and pesticide impacts on ground water be addressed and implemented. The ISDA recommends that:

- Growers and agrichemical professionals conduct nutrient, pesticide, and irrigation water management evaluations.
- Producers follow the Idaho Agricultural Pollution Abatement Plan and Natural Resources Conservation Service Nutrient Management Standard.
- Producers and agrichemical dealers evaluate their storage, mixing, loading, rinsing, containment, and disposal practices.
- Dairy and feedlot facilities assess animal waste management.
- Homeowners assess lawn and garden practices, especially near wellheads.
- Local residents assess animal waste management practices.
- State and local agencies assess impacts from private septic systems.
- Home and garden retail stores establish outreach programs to illustrate proper application and management of nutrients and pesticides.
- Responsible parties assess current pesticide application practices to non-crop areas (such as roadsides, railroad areas, etc.).

The ISDA recommends that the Owyhee Soil and Water Conservation District lead a response process to create a plan of action to address these ground water contamination issues. The soil and water conservation district should work with local agrichemical professionals, landowners, and agencies to implement this process and seek funding to support these efforts. The ISDA will support these local partners in seeking funding and implementing a comprehensive program.

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